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ABSTRACT

Emphasis on the information science field has grown in the past several decades because of five interrelated factors: time scale changes, changes in quantity of available information, changes in nature of information requirements, changes in importance of information sources, and an increase in the number of information processing agencies. The computer, modern communications technology, and new means of information organization and dissemination all have an effect on the traditional concept of a library. The author discusses the implications of these factors of modern technology for the library and information center of the future, the campus-based information systems, the field of information science and education, and the media involved in the field of library and information science. (JY)

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Information Science: Media Implications of the New Means of Information Organization

by Allen Kent*

The field of information science is derived from the struggle of man to control his environment, or at least to avoid being destroyed by external forces. The struggle articulates into requirements to make decisions continually. The quality of the decisions is dependent fundamentally on the problem-solving capability of the decision-maker, but initially on the quality and relevance of information brought to bear on the problems. Here, then, is the fundamental rationale for man to accumulate and organize information relating to past accomplishments of civilization.

Emphasis on the information science field has grown in the past several decades because of five interrelated factors:

(1) TIME SCALE CHANGES

The time scale of information gathering for decision-making and control has been reduced drastically. This change corresponds to increases in the rates with which competitive activity, international aggressive action, and changes in public opinion can deteriorate economic, military, and political situations.

(2) CHANGES IN QUANTITY OF AVAILABLE INFORMATION

There has been a dramatic increase in the amount of information that is freely available (i.e., published in one form or other), resulting in the characterization of the situation as an information explosion. This situation has three dimensions of frustration:

(a) The impossibility of an individual reading and remembering all of the literature that has a reasonable probability of being of later use.

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(b) The economic impossibility of individuals or their organizations processing for later retrieval the majority of literature of probable pertinent interest.

(c) The breakdown of traditional library tools in coping effectively with the detailed requirements of individuals in identifying information pertinent to a given problem.

(3) CHANGES IN NATURE OF INFORMATION REQUIREMENTS

The increasing complexity of the problems of society has led to a consequent requirement for information from an ever-widening diversity of fields. This has resulted in the need to achieve insight into otherwise obscure or uncertain situations through the use of large amounts of fragmentary information from widely scattered sources.

(4) CHANGES IN IMPORTANCE OF INFORMATION SOURCES

The increasing internationalism of industrial, educational and political organizations has been leading to increasing emphasis on information for decision-making and control derived from many sources and geographic areas not formerly considered important. This trend has increased the need for obtaining and providing information quickly which heretofore could be transmitted on a more leisurely basis.

(5) INCREASE IN NUMBER OF INFORMATION PROCESSING AGENCIES

The four changes described above have resulted in various agencies undertaking information processing and disseminating functions. These include governmental agencies, professional and trade associations, universities, and profit-making industries. This trend has led to an unquantifiable overlap in processing and services.

In consequence of these changes, new tools, new communication systems, new means of information organization, and new means of dissemination have been proposed and developed. Each in turn has both helped alleviate the problems, and uncovered new and fundamental problems.

(1) Influence of the Computer

(a) Logical Capabilities

The use of computers to search indexes to large files based on logical combinations of subjects has led to the trend to increasing depth of analysis of source materials, which in turn has increased the cost of such analysis to the point where few organizations have the wherewithal to process for their own use the information that would be of possible use in the future. This has led to centralization of information processing activities, e.g., by government agencies and professional societies, and an attempt to amortize the cost over many users. But centralized services have been imperfect, and decentralized as well as specialized information centers have been developed in an attempt to overcome some of their limitations.

(b) Processing Speed Capabilities

The speed with wich computers can search large files carries with it a consequent high cost. In an attempt to amortize this cost over many users, there has been a trend to utilize the batch processing capabilities of computers to handle as many questions as possible at one time. But the consequences of this trend is a decrease in effective speed of search, since time elapses

while a sufficient quantify of search requests are accumulated. This has led to consideration of how time-sharing computers may be utilized to provide search results in real time. The processing speed of computers has also led to consideration of how whole texts may be searched to advantage. But this consideration brings up the problem of whether algorithms can be developed which apply the test of significance of information as opposed to mere identification of words that may appear in a given text.

(2) Influence of Communication Systems

Modern communication technology offers the opportunity to transmit information in the form of data, voice, and images. Theoretically, this technology would permit the information resources of all organizations to be shared by permitting remote inquiry through an appropriate network mechanism. The availability of time-sharing computer systems with their ability to tie into network systems makes it possible to contemplate an inquirer sitting at a remote console interacting with a multiplicity of information resources in real time. However, in considering how to translate theory into practice, it becomes obvious that fundamental knowledge is lacking with regard to the following questions:

(a) How can the differing philosophies of analysis of source materials and differing means of vocabulary control be rationalized when several resources are to be exploited to serve a single inquiry?

(b) What criteria would inquirers use in judging relevance of information provided in an interactive mode when networking systems employing modern communication technology are used?

(c) What will the behavior of an inquirer be if he has the opportunity to conduct information searches personally through a console? What training problems will be involved? What programs need be written to provide an adequate conversational mode in this regard?

(3) Influence of New Means of Information Organization

The pressures for greater and greater penetration into the subject matter of source materials have been evident as the quantity of published information has reached the point where traditional classifying and indexing methods are not able to provide literature search results with the precision, relevance, and quantity limitations being demanded. In other words, the requirement for precise specification of problems and questions of inquirers has led to consideration of corresponding means for precise specification of the subject matter of the source materials. This consideration has led to increased pressure for subject analysis expertise which approaches the expertise of the inquirer. On the other hand, the personnel requirements for processing the increasing quantity of source materials have not been matched by available skilled manpower. Consequently alternative methods of processing have been considered, proceeding successively through the use of:

(a) generalists rather than specialists; and

(b) automatic means for analysis of information, involving either portions or the entire text of the source materials.

Study of the results of application of both of these methods indicate that imprecision and inconsistency in analysis is not avoided, leading to uncertainty in the exploitation of large files. Accordingly, other means have been sought to overcome the consequences of this uncertainty. Explorations have resulted in the development of various vocabulary control and search strategy techniques. Testing and evaluation of these techniques has become a matter of increasing attention, leading to the identification of increasingly fundamental problems relating to:

(a) the nature of information transfer from source materials to the inquirer;

(b) the criteria for relevance judgments of inquirers, and their dependence on incremental learning;

(c) the nature of concept formation; and most basic of all;

(d) the learning and thinking processes.

(4) Influence of New Means of Dissemination of Information

It has been interesting to observe the development of means for dissemination of information in such a manner as to correspond selectively to the "profile" of interests of inquirers, thus keeping them informed periodically of published materials in the precise areas of their professional work. However, the changing interests of many inquirers requires that careful attention be paid to means for obtaining feedback which permits dynamic

response to indications of changes, or even saturation of interests. The need for development of means for observing inquirer behavior without undue interference with normal work habits has led to consideration of the methodology of the behavioral sciences. But this methodology must take into account the fact that the average information user can spend only minor fractions of his time relating to information services. Accordingly, the mass effects of new dissemination methods can be discerned only with large populations of users, leading to the need for the careful application of statistical methods to discern real effects and their significance.

The foregoing have stimulated consideration of matters relating to the traditional libraries, and the very significant investment that has been made by society in their development and maintenance. Increasing demands for library service, even of a traditional nature, have led to investigations of how the new tools and communication systems might streamline these functions, which despite the growing importance of information storage and dissemination centers, still is the main instrument of society for democratic access to recorded knowledge. Resulting has been the application of computers and other data processing equipment to the control of circulation records, serial records, and even to the conversion of catalog information to machine-processable form. Initially this latter application was considered for purposes of convenient up-dating and publication of book catalogs. However, the availability of this information in machine-processable form has led to some effort toward providing real-time access by library users. And attempts have been made to exploit the logical capabilities of the computer for identifying books and monographs in a

manner that is analogous to the way in which they are used for information retrieval in depth for documents and published papers. But the paucity of subject headings normally provided during subject cataloging has made this approach unrewarding. So methods are being investigated for more detailed analysis of books and monographs, a problem that is far from trivial.

The advanced communications technology has been exploited in connection with interlibrary loan procedures (the traditional library response to resource-sharing requirements). The location of desired materials has been facilitated by the mechanism of almost real-time communication systems such as teletype. In addition, image-transmission systems are being considered for the provision of copies of materials without physical removal from existing collections.

But the services that are emerging and will develop are much more costly in visible expenditures than traditional activities, and the question must be explored regarding how to market these services, either through filling overt requirements or through stimulating interest that did not exist before. This has not been a trivial problem, since the library function has been considered to be free to society ever since the principle was established by Andrew Carnegie toward the end of the 19th century.

There are also legal implications involved in the application of the new technology in the library and information sciences. The convenience of providing copies of published materials and the accelerating trend toward conservation of storage space through the use of microform brings up consideration of violation of copyright through promiscuous processing, copying, and transmission of such materials. This legal problem, and the related economic problems is causing concern and investigation of the consequences to various elements of society: the publisher, the authors, and the user public.

B. The Library and Information Center of the Future

1. Introduction

Information science programs are being designed to respond to the problems incurred by the information explosion by hypothesizing that the library which is to serve future generations is more than bricks and mortar. It will not be useful if it is to be a book warehouse--manned by book keepers. Rather, the library of the future must be created as an organism for performing work, for providing service, and for conducting research. This organism will be responsive to the changing requirements of a dynamic field, with responsibilities in education, in research, and in practice. The most modern and flexible mechanisms will be available for exploiting recorded knowledge in the interests of professional advances.

The director of the library of the future will be a library and information scientist, an educator, and a research director. He will draw about himself a constellation of specialists from a number of professional disciplines.

Some new libraries have been designed modularly (to permit physical expansion); functionally (to facilitate the performance of technical services); reader-oriented (to better serve the client); and librarian-oriented (to convenience the internal staff). The new programs must consider a new need--for a library designed for intellectual growth through research.

The articulation of information science programs is based on the thesis that there is need for access to recorded knowledge that must be satisfied by providing rapidly, conveniently, economically, and with precision, that portion of the current or previous literature that will be useful

--to a particular individual

-- at a particular time

--for a particular problem or interest

--and in a form that is useful to him

regardless of

--where it was generated

--in what form or language

--or how it must be located and processed

The utopian dream is to have information available on the day of publication, neatly translated into one's mother tongue, and packaged in quanta which are of infinitely variable size and content.

The translation of this dream into a program involves changing concepts of information handling. Some of these concepts are discussed in the following:

a. Information as a Physical Commodity

Library materials, including books, periodicals, and reports, have traditionally been stored physically on shelves and selected on a "custom" basis, either by library staff or by the reader. In more modern terms, the significant amounts of library materials to be moved into and out of storage can be considered from an industrial engineering point of view as:

(1) a warehousing and materials handling problem, with selection, delivery, and return to storage conducted mechanically

(2) a manufacturing problem, with materials stored in microform, and access provided locally and to distant locations through:

(a) provision of returnable copies by mail or other physical means of transfer

(b) provision of disposable copies by mail, or by telecommunications techniques

(c) transmission of materials by means of television techniques with option of preparation of copies locally from the face of cathode ray tubes

(d) stocking of subwarehouses with microform copies and providing access to information via mail or telecommunication media.

b. Information Retrieval as a Data Processing Problem

The available stockpile of information can be considered in modern terms as a data processing problem, with various types of equipment available for manipulating indexes to the physical storehouse of information from a multidimensional point of view. By this is meant that source documents may be characterized from more than one point of view and also identified for delivery by combining more than one aspect of subject matter--by applying clerical, mechanical, or electronic means to perform selecting and correlating operations.

c. Information Retrieval as an Intellectual Problem

In traditional terms, the library activity has been an art, with analysis of documents and reference services considered to be techniques which are learned through apprenticeship after suitable training. However, the greater demands being placed on the library have resulted in the realization that specialists in other fields can make a significant contribution to the intellectual problems facing the field. Accordingly, there has been an infusion of linguists, logicians, mathematicians, electronic engineers, psychologists, and other specialists who have been considering means for the

solution of theoretical and practical questions that are encountered in communicating via the written record. These specialists have been deeply involved in the forward research work leading to the development of more sophisticated automatic information retrieval systems.

d. The Library in Terms of Technical Processes

A library represents different things to different people. To many library staff members, the library consists of a number of technical processes involving: selection of books, periodicals, or other materials; ordering of materials; binding; cataloging; copying; etc. These technical processes can be considered from an engineering point of view as unit operations, which are conducted in a "production" environment, with modern business methods being applied to carry them out and to keep track of them. Various methods of automation are now being considered for each technical process of the traditional techniques and for many of the unit operations newly identified in more modern approaches.

2. Development of Campus-Based Information Systems

The scholarly community is becoming increasingly aware of its information environment. This awareness has been stimulated by a number of factors, not the least of which is the increasing realization that keeping up to date through reading the book and periodical literature in its classical form is becoming less and less convenient as the scope of interest of scholars becomes increasingly interdisciplinary and the quantity of literature of potential relevance becomes greater.

Communication among scholars through personal contacts, although increasing dramatically, is not likely to provide assurance that even the most fruitful contacts can be assured in a timely way through serendipitous discovery of communities of interests.

An impressive array of centralized and specialized information services, both discipline- and mission-oriented, are available, under development, or being planned. It has been hypothesized that these services will be augmenting or, in some cases, replacing the traditional library services that have been used by scholars in many or even most fields of endeavor. But exploitation of each of these new services, many computer-based, involve overt expenditures of funds which, in a university, may often equal and, sometimes, exceed the budgets for purchases of books and other materials of the library system. These overt expenditures, when multiplied by the number of services that are now, and may soon be available present a budget dilemma that has not often been contemplated seriously by university administrations.

It is not enough to say that funds are not available to support these new services that will be demanded by the scholarly community. Rather, like the conclusion reached in contemplating increasing budgets for conventional

libraries, that some academic programs cannot be maintained without ready access to adequate library collections, so it may be said for these new services that some programs should be excluded from the curriculum if ready access to these new services cannot likewise be assured.

Nor is it enough to rely on grant support to establish campus-based information centers, since interest in services from these centers stimulated during the grant period will have to be satisfied following the period of sponsored development.

Rather it is necessary to predict the dimensions of the information problem; to design an information system which not only brings replicas of files to the campus but also provides remote access to other files when it is more convenient or economical to do so, and to develop plans for financing the operation of the system.

In developing such plans, the starting premise must be that faculty and students are to be provided with the most effective secondary information services that may be technologically feasible. It is known that any given educational institution will never be able to create such services de nova and that each would always wish to interrelate, on some basis or other, with many discipline- or mission-oriented services. This relationship would involve acquisition of, or remote access to, search-ready files, mostly involving the use of computers for exploitation purposes.

It is assumed that the costs of providing such service at the level and frequency desired will eventually exceed the ability of the institution to cover such costs when the expected lease, royalty, capital, and operating expenses are all taken into account, once the period of sponsored research has passed. Accordingly, a basis for amortizing basic operating costs over a group of users larger than any single educational institution must be sought.

Accordingly, successive expansion of the base of users must be considered so that resource-sharing economies may be achieved.

But, it has become obvious that many, or most, organizations are not willing to pay the full costs of obtaining services unless a "one-stop" service is offered. That is, assurance is demanded that the services to users are based on exploitation of all of the resources relevant to a given interest.

It is entirely reasonable for fee-paying users of information services to demand such assurance, since otherwise other sources would have to be exploited by the users independently, with attendant substantial fees, but without obviating uncertainty as to the extent of overlap in coverage among the services exploited.

This situation provides an additional incentive to the educational institution to interrelate with as many services as are willing and able to provide access to their data bases for purposes of local or regional exploitation.

C. Information Science and Learning

Discussions of the information explosion and its consequences have emphasized primarily the increasing difficulty of any professional being able to read all of the published literature that is of interest and of consequence. This situation has led to a trend toward increasing specialization in an attempt to reduce the amount of information that must be assimulated by any individual to manageable proportions.

It comes as no surprise that this trend toward specialization has led to increasing difficulties in communication among specialists. Furthermore, the specialist, when he must exploit literature peripheral to his specialty, finds it more and more difficult to use traditional library facilities to penetrate the subject matter and to obtain information relevant to his requirements.

This problem has provided impetus to the development of information storage and retrieval systems, involving the use of non-traditional techniques and devices, particularly computers.

However, there is another matter that may not be as evident that is related to the knowledge explosion problem. One of the consequences of information overload has been, and continues to be, increasing emphasis on teaching of principles rather than facts, at all levels of the education continuum. This shift in emphasis does not relieve the student from the burden of being able to locate facts which may be needed during his educational experience and later, which relate to the principles he has learned, and which can be related to the intellectual framework of the subject matter that a student has acquired. This implies an increasing burden on libraries and information retrieval activities to permit ready identification of information on demand.

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The problem is complicated by another factor relating to this shift in emphasis. When certain information has not been provided to a student during his educational experience, questions directed to the library or information center are no longer based on a "recall" function, since the student may never have been exposed to the information which he wished to locate. Rather, questions are now derived from the student's knowledge of principles, leading to the identification of characteristics of the desired information rather than the information itself. This change in the nature of question-asking leads to the requirement that information stored for later retrieval must be analyzed in sufficient depth so that this new type of question can be asked with some confidence in effective searches being performed.

More and more, then, learning and information retrieval become interrelated as the information explosion develops further, with an increasing requirement that students be taught how to exploit effectively the libraries of the past and the information centers of the future. How to infuse into the educational experience a thorough knowledge of the library and information sciences of the future, is a challenge that must now be faced.

The increasing availability of time-sharing computer facilities has made it possible to consider the development of conversational programs which provide instruction regarding formulation of strategies for exploiting computer-processable files. Although several such efforts are now underway, the programs are still untested and not generally available. However, it may be anticipated that as these programs become increasingly available, there will be stimulated a demand for on-line files, so that searches may be performed by an individual through a console following successful negotiation of a search strategy. This, in turn, would lead to demand for

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provision of images of printed materials via a console, presenting a requirement for image transmission capabilities from remote locations.

D. Media Implications

From the foregoing, it may be obvious that there has been a shift in media involved in the library and information science field, with regard to: (1) generation and storage of records; (2) inquiry; and (3) response to inquiries.

(1) Generation and Storage of Information

Traditionally, the printed page has been the primary medium for storage of information. Although this medium will probably continue to handle the bulk of storage requirements, other media are being used increasingly including: film (including microform); magnetic tapes; and discs.

(2) Inquiry

Reference to information-locating tools has traditionally been dependent on printed records, e.g., catalog cards, and printed indexes. However, it may be expected that increasing use will be made of consoles, which permit direct inquiry via other media, such as keyboard inputs to computer-based files or cathode ray tube displays which permit formulation of requests based on light pen selections from available alternatives.

(3) Response to Inquiries

Traditionally, delivery of materials in response to inquiries has used the medium of hard copy. Now, the opportunity presents itself to display images via consoles with an option to produce hard copy locally. Also, for materials stored in an audio medium, audible signals may be transmitted in response to an inquiry.

The technology that permits communication systems to handle these media has been developed to the point where it is possible to demonstrate the efficacy of such approaches. However, the economic impact of such technology seems, on the surface, to be destructive. Nevertheless, network development to permit the provision of data, voice, and image transmission capabilities is contemplated as the way to share costs (as well as information resources), so that, given full loading of the proposed and developing systems, the cost of each use should be well with plausible limits.

The development of a telephone network, which has illustrated this principle, provides hope that media of various sorts can be handled efficiently and economically.